



Armed Forces College of Medicine AFCM



Muscle Tissue-1

Ass. Prof. Walaa Baher Mostafa

INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture, the student should be able to:

- Describe the organization of the skeletal muscle
- Describe the structure and correlated functions of the muscle fibers
- Describe the structure of the myofibrils
- Describe the structure and correlated functions of the sarcomere.

Classification

1. **According to morphology:**

A. Striated

B. Non striated

2. **According to function:**

A. Voluntary

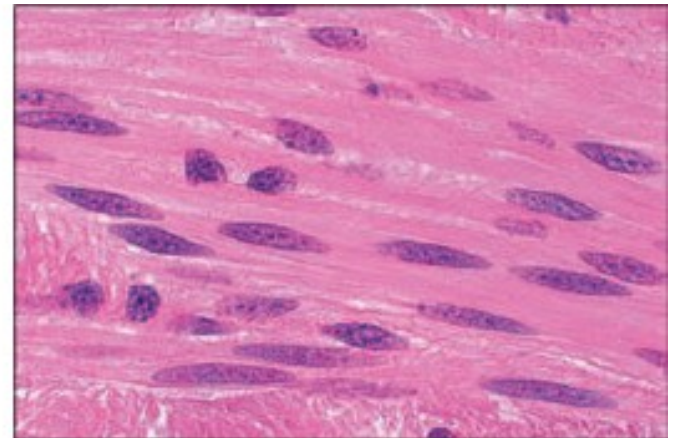
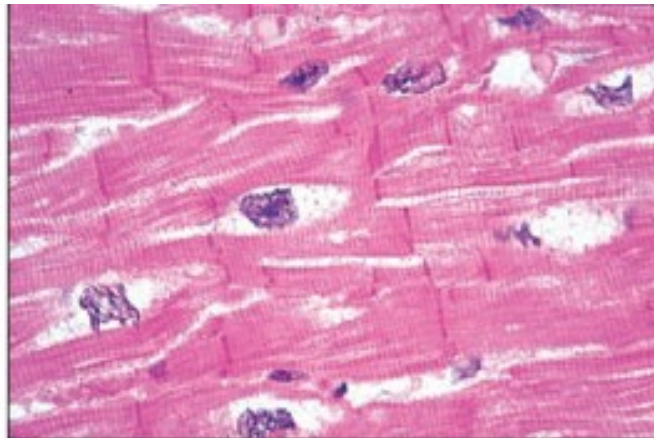
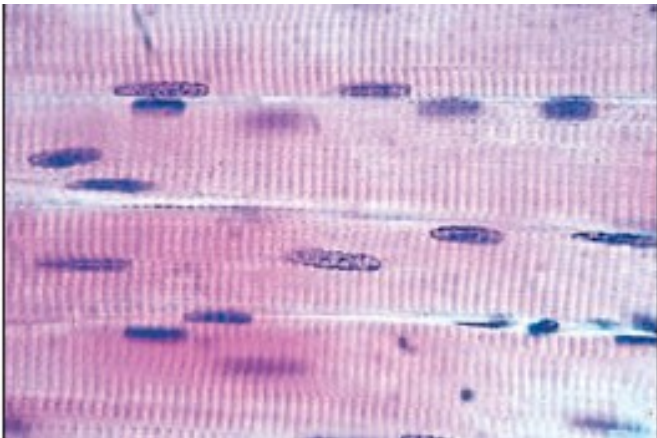
B. Involuntary

TYPES OF MUSCLE

1. **Skeletal muscle:** striated & voluntary

2. **Cardiac muscle:** striated & involuntary

3. **Smooth muscle:** non striated & involuntary



Microscopic features of muscular tissue

- 1) It is formed of Muscle Cell (**Muscle fiber**)
- 2) The cytoplasm is called **Sarcoplasm**
- 3) Sarcoplasm contains {myofibril-sER-mitochondria-myoglobin} to serve its contractile function.
- 4) SER is called **Sarcoplasmic reticulum**
- 5) The plasma membrane is called **Sarcolemma**

Skeletal muscle

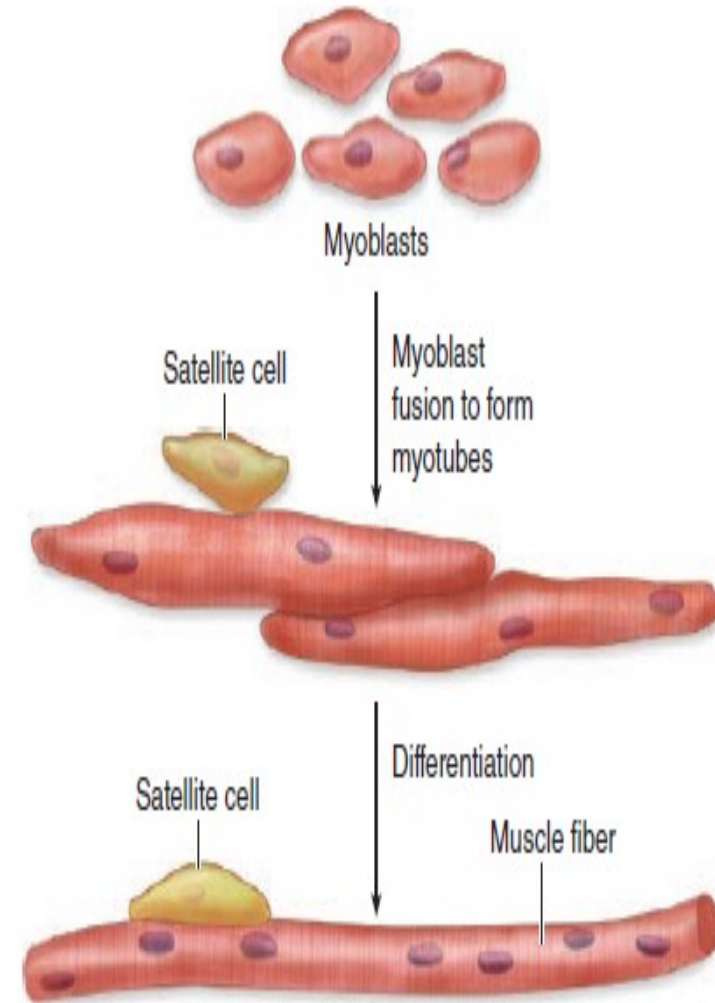
Skeletal Muscle

- **Origin:-**

1. Prenatal life: Myoblast → myotubes → muscle fiber

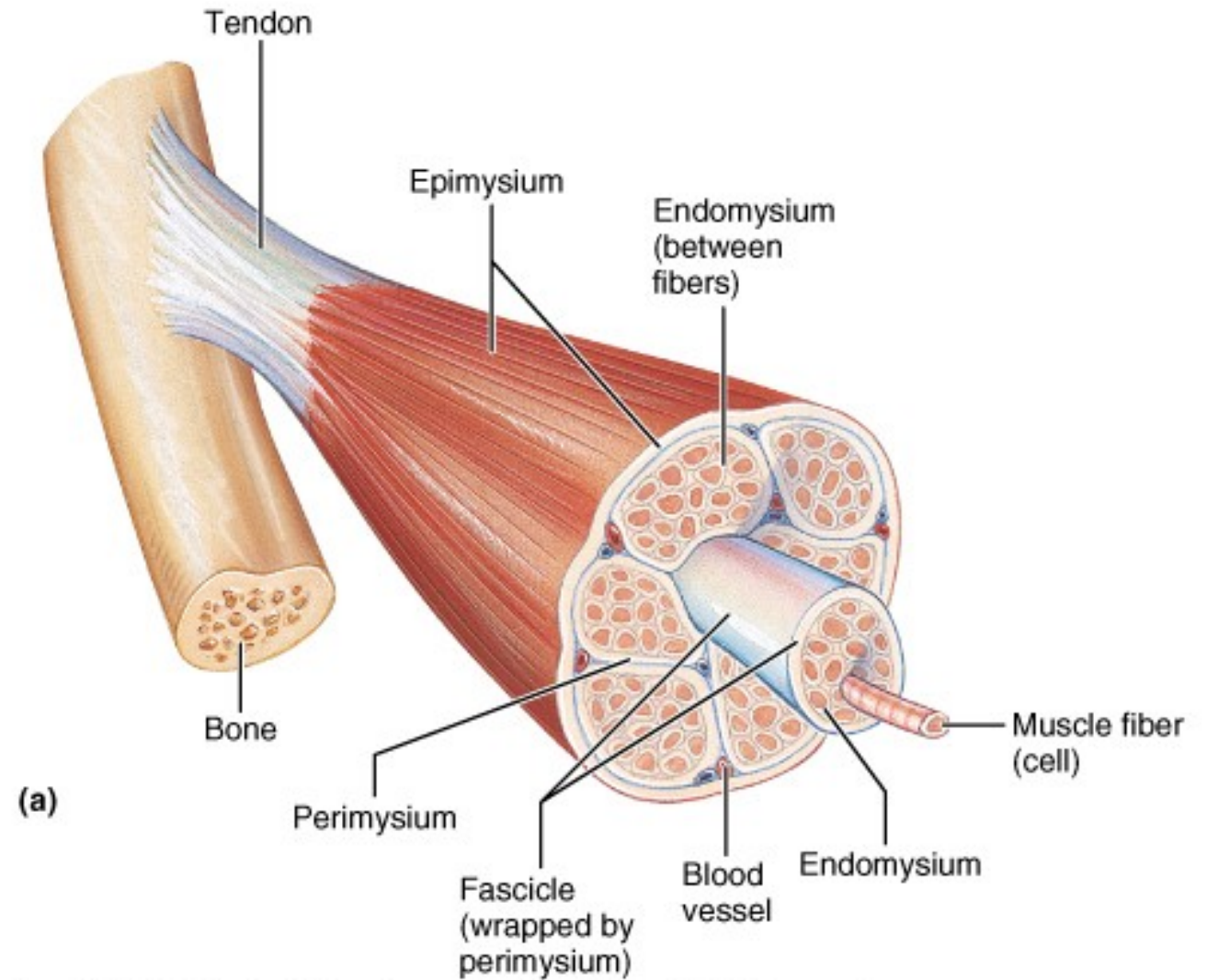
2. Postnatal life: Satellite cell (*myoblast population does not fuse and differentiate but remains as a group of mesenchymal progenitor cells*)

- Growth & repair of skeletal muscle occurs by satellite cell.
- Hypertrophy-hyperplasia???

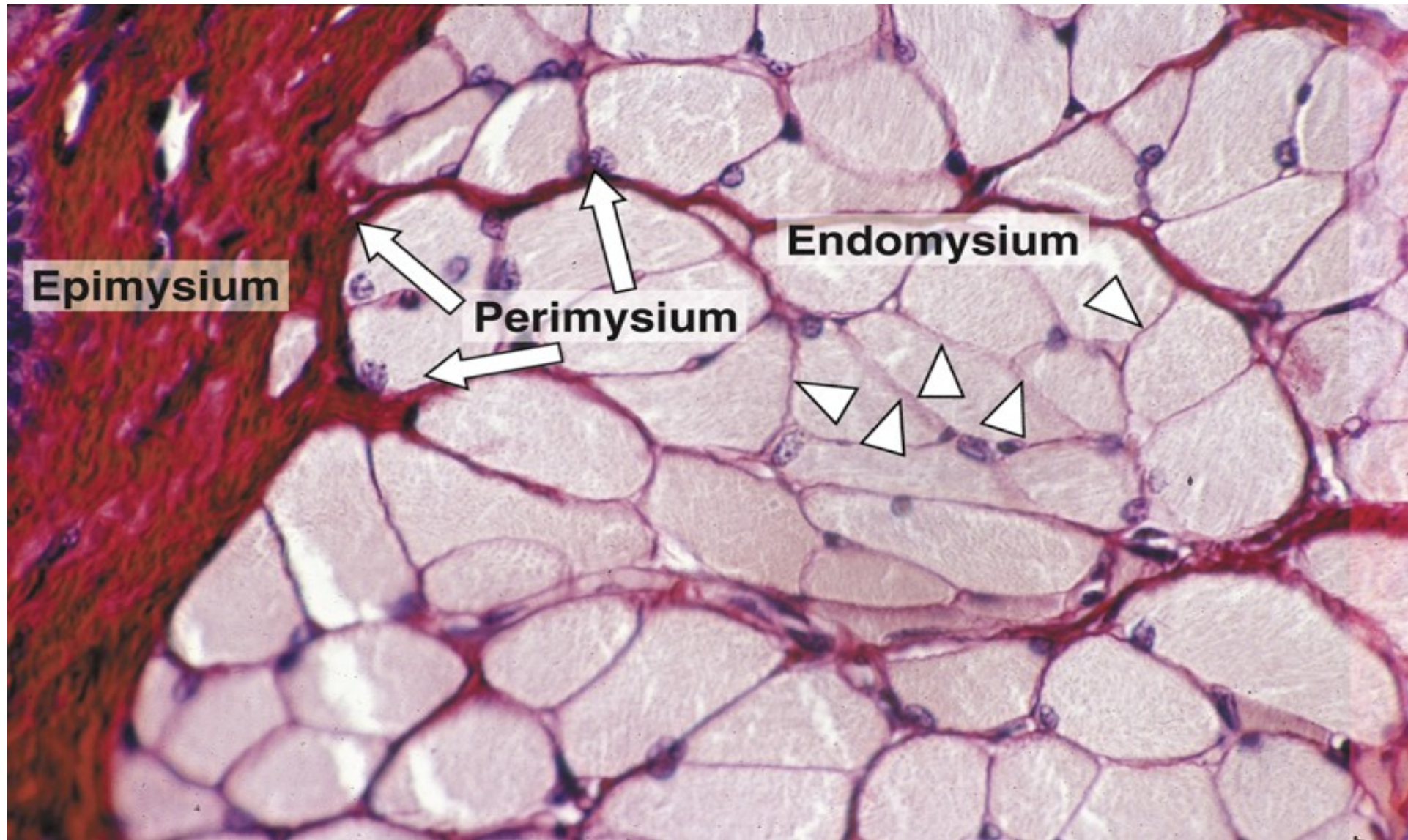


The connective tissue wrappings

Organization of a skeletal muscle



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Cross section of striated muscle stained to show collagens type I and III and cell nuclei. The **endomysium** is indicated by arrowheads and the **perimysium** by arrows. At left is a piece of **epimysium**.

Connective tissue of skeletal muscle

- 1) **Epimysium**: dense CT covers the **whole muscle**.
- 2) **Perimysium**: dense CT surrounding each **muscle bundle**.
- 3) **Endomysium**: reticular fibers & fibroblasts surrounds **individual muscle fibers**.

Function: it carry blood vessels & lymphatic & nerves to the muscle.

Muscle Fiber by light microscope



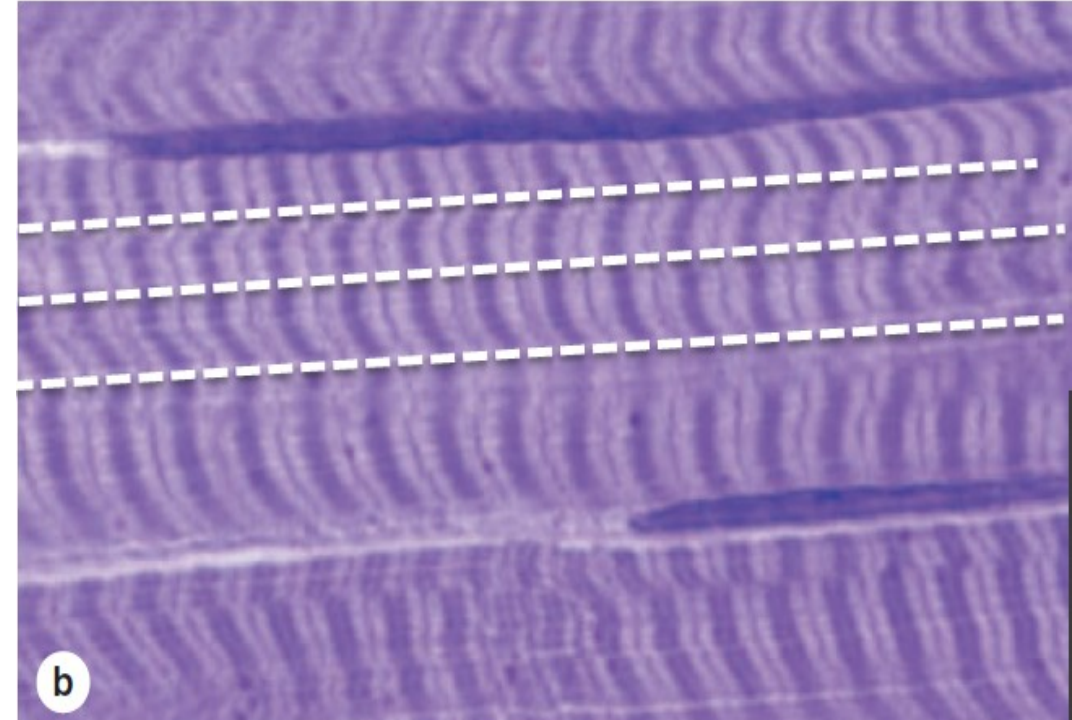
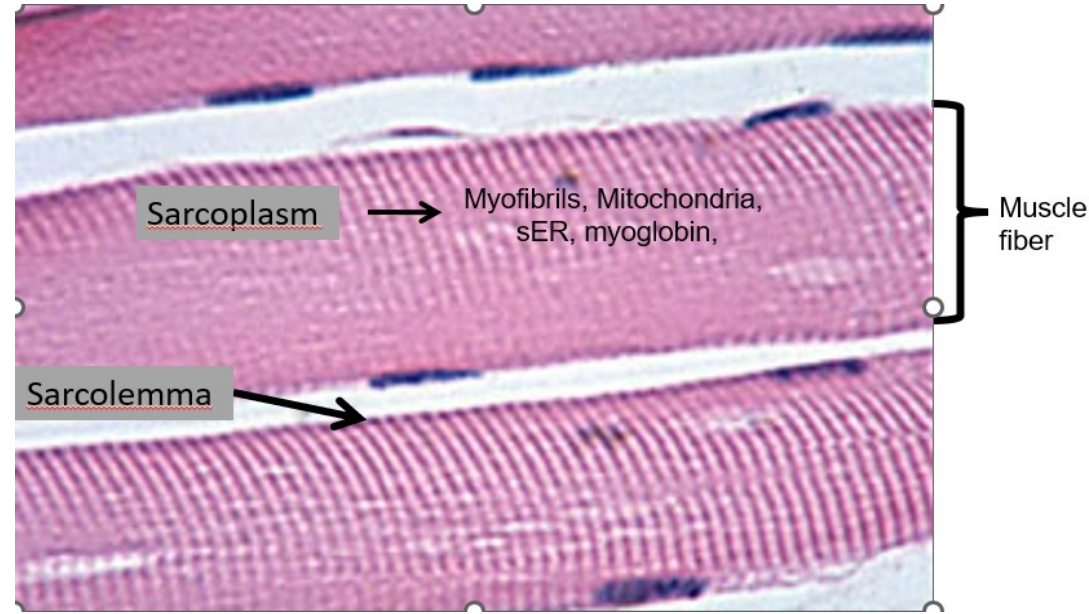
Light Microscope features of LS of skeletal muscle

1. Shape:

- Cylindrical, non branched muscle fiber
- Surrounded by **sarcolemma** and separated from the surrounding C.T. by external lamina (+ve for laminin).
- It has wide diameter (10-100um)

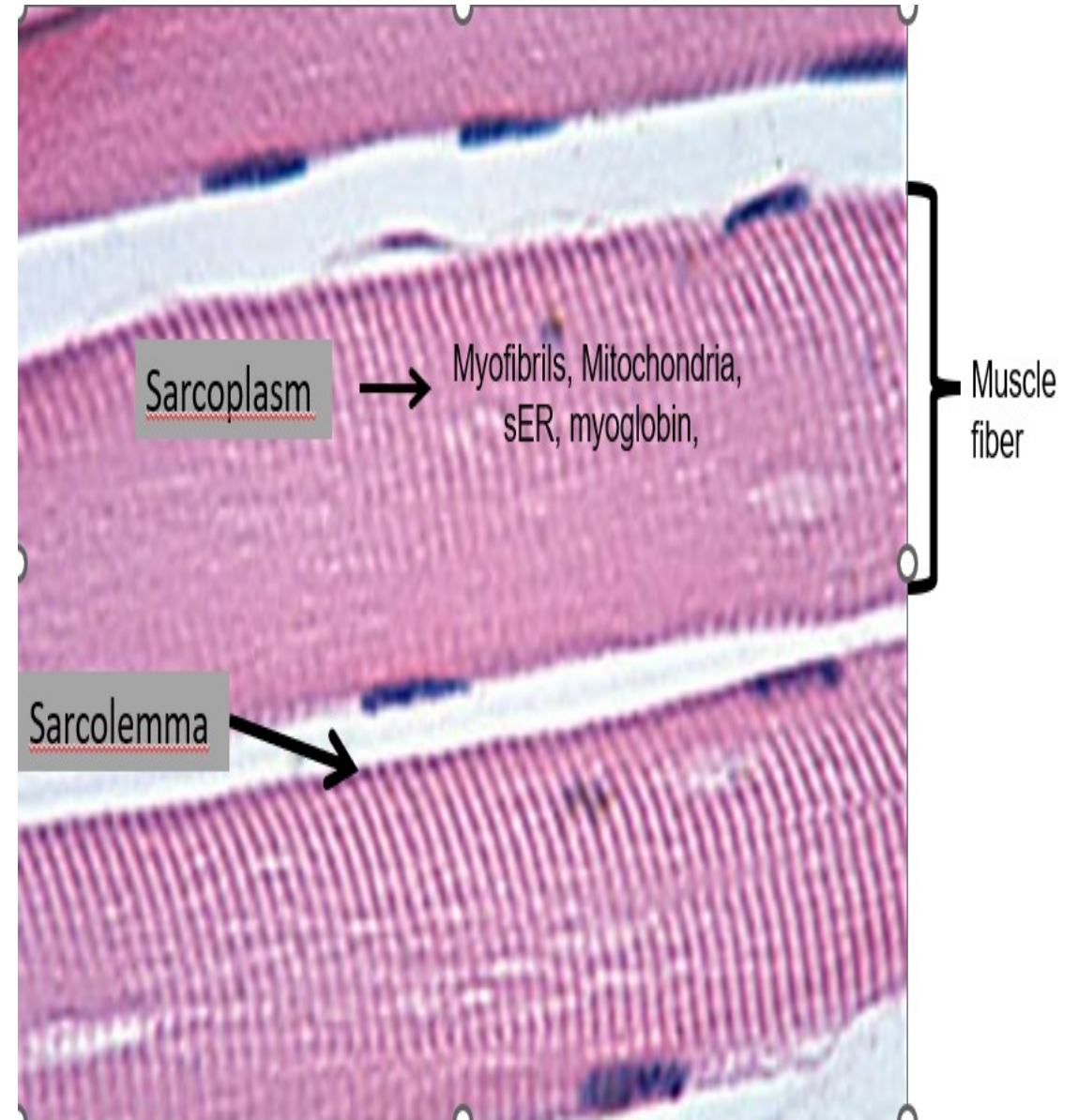
2. Cytoplasm (sarcoplasm):

- It is **deeply acidophilic**.
- It shows **cross striations** of alternating light and dark bands
- It is rich in **myoglobin & glycogen**.
- Filled with long cylindrical bundles **myofibrils** that run parallel to the long axis of the muscle fiber
- The dark bands on the myofibrils are called **A bands**; the light bands are called **I bands**.



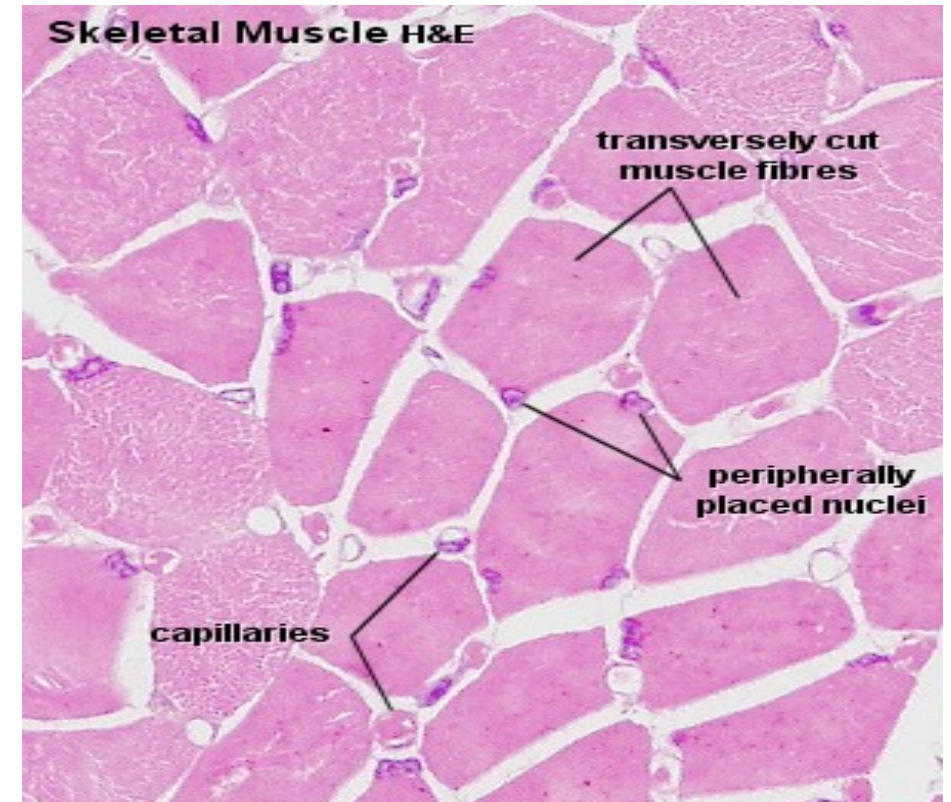
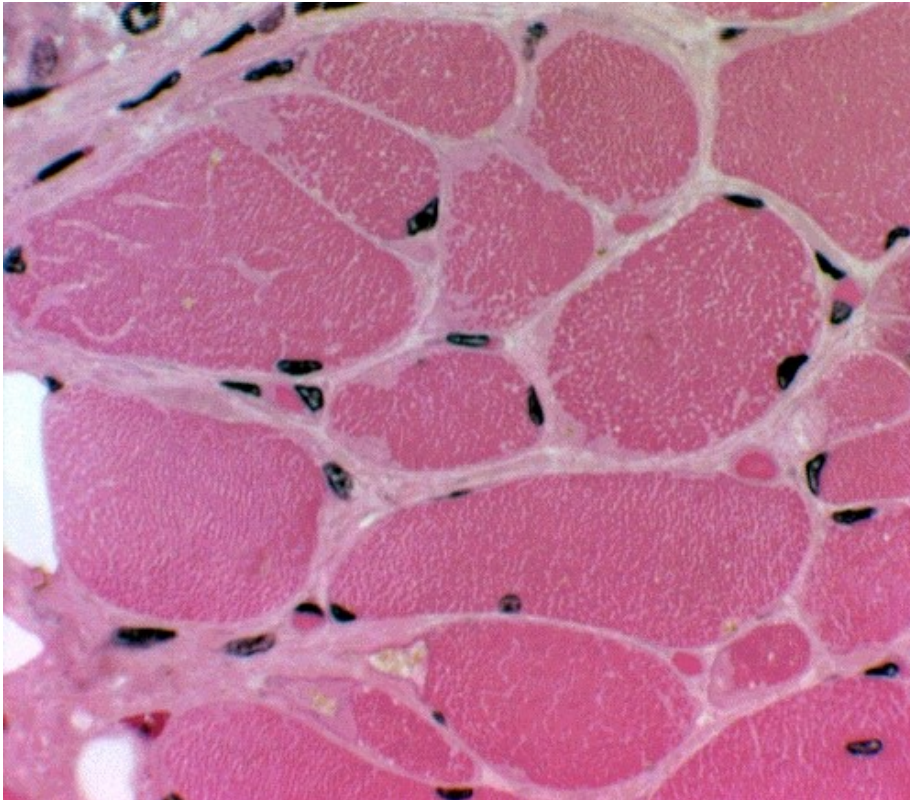
3. Nucleus:

- Multi-nuclated cells.
- With flat oval nuclei.
- They are peripherally situated (just under the sarcolemma & parallel to it)



Light Microscope features of TS of skeletal muscle

- Rounded or polygonal
- Equal diameter
- Peripheral nuclei



Muscle Fiber by electron microscope

I. Organelles:

1. Myofibrils & myofilaments (sarcomere).
2. Sarcolemma & transverse tubules.
3. Sarcoplasmic Reticulum.
4. Mitochondria , Golgi & Ribosomes.

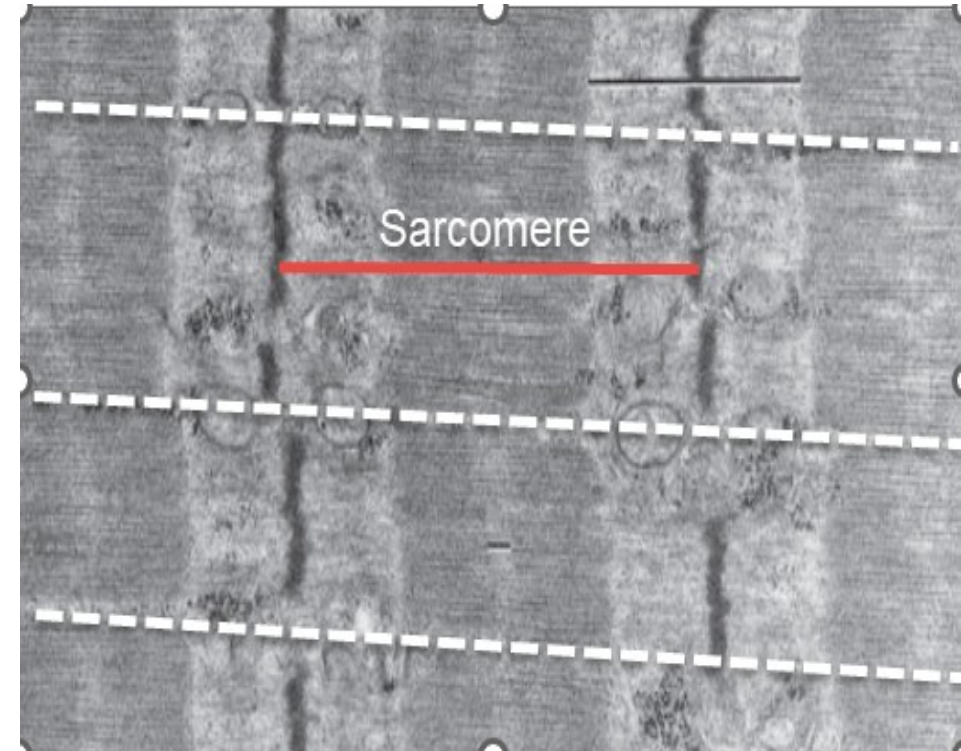
II. Inclusions:

-Myoglobin & glycogen



Muscle Fiber by electron microscope

- Sarcoplasm contains longitudinal parallel **myofibrils**
- Each myofibril is formed of repetitive functional units called **Sarcomeres** (about 2.5- μm long in resting muscle) □ characteristic pattern of transverse striations (**Give reason for?**)
- **Mitochondria, sarcoplasmic reticulum, and glycogen granules** are found



Myofibrils

Each myofibril is formed of a number of **myofilaments** arranged in **sarcomeres**

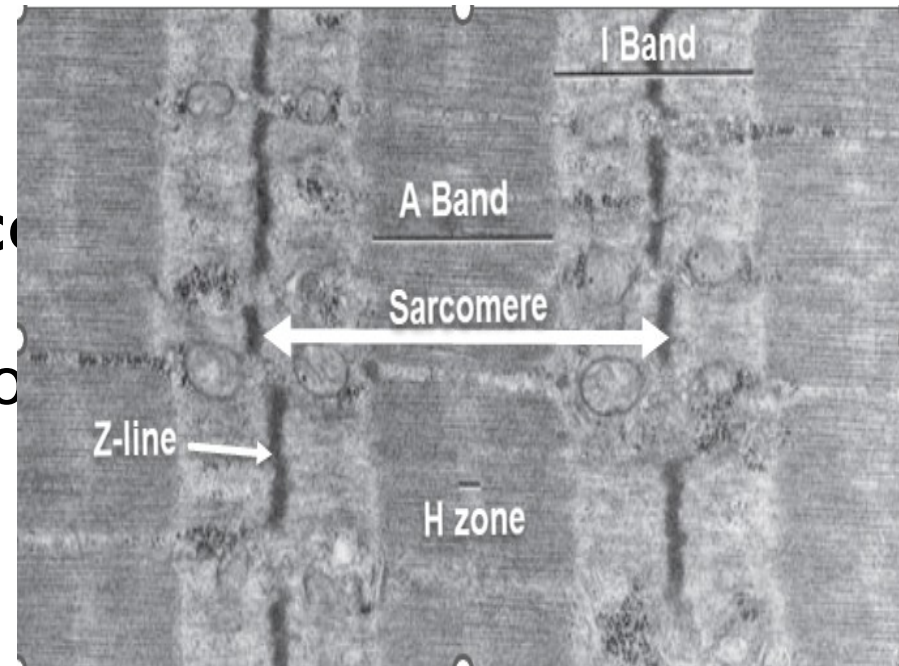
The A and I banding pattern in sarcomeres is due to the regular arrangement of thick and thin **myofilaments**, composed of **myosin** and **F-actin**, respectively

Sarcomeres are the **functional and structural muscle**.

Each sarcomere is the **area between two successive Z-lines**.

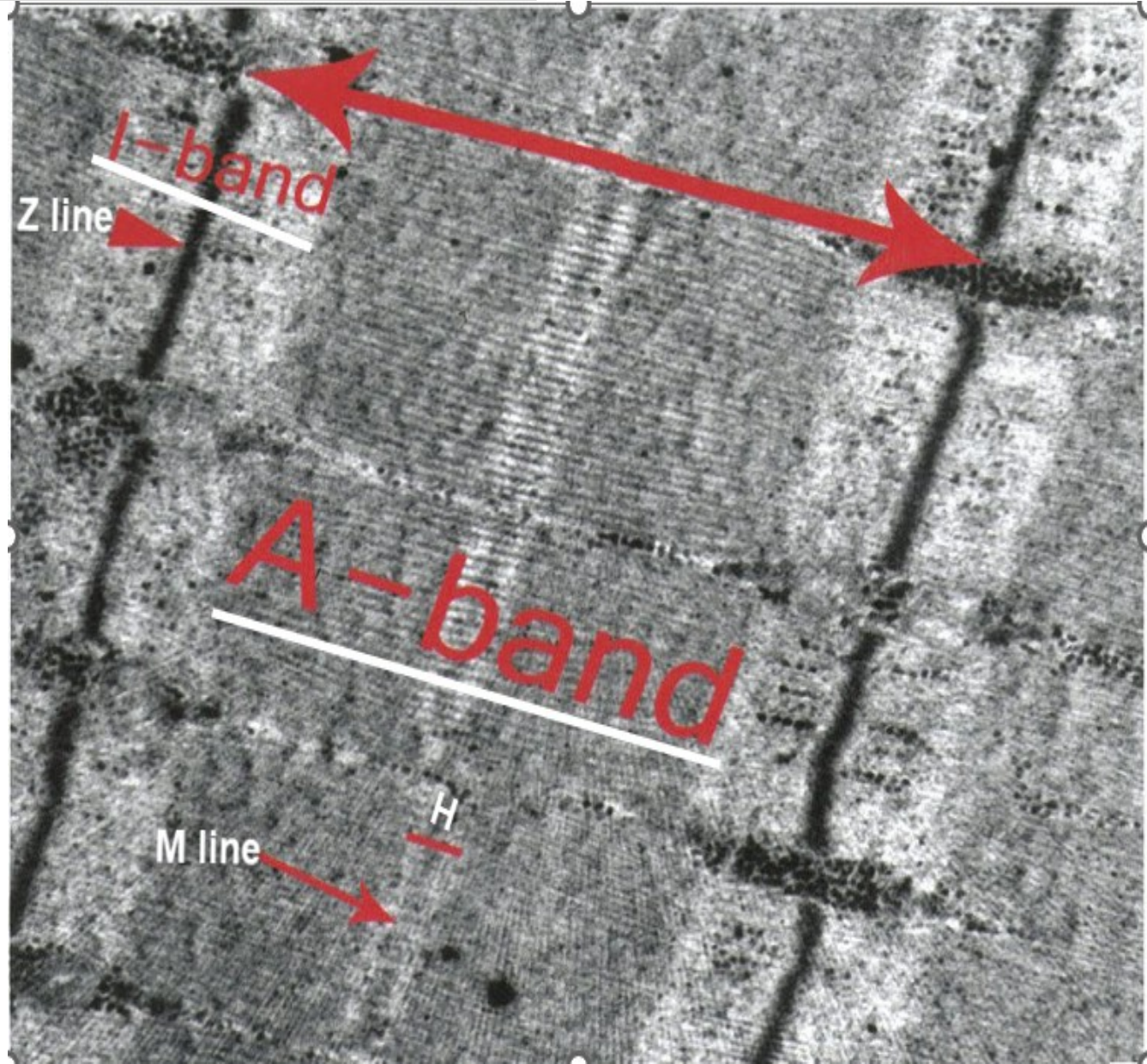
The arrangement of myofilaments in sarcomere follows the following pattern:

- A Band (1 per sarcomere)
- I Band (2 halves per sarcomere)
- H zone
- M line



Sarcomere

- Functional contractile unit.
- Bet. 2 successive Z line.
- **Sarcomere consists of:**
 - **Dark band (A-band)** in the middle.
 - **Half of light band** on either side.
 - **H zone:** in the middle of A band.
 - **M line** (in the middle of H zone).
 - **Z line:** limiting the sarcomere on both sides.



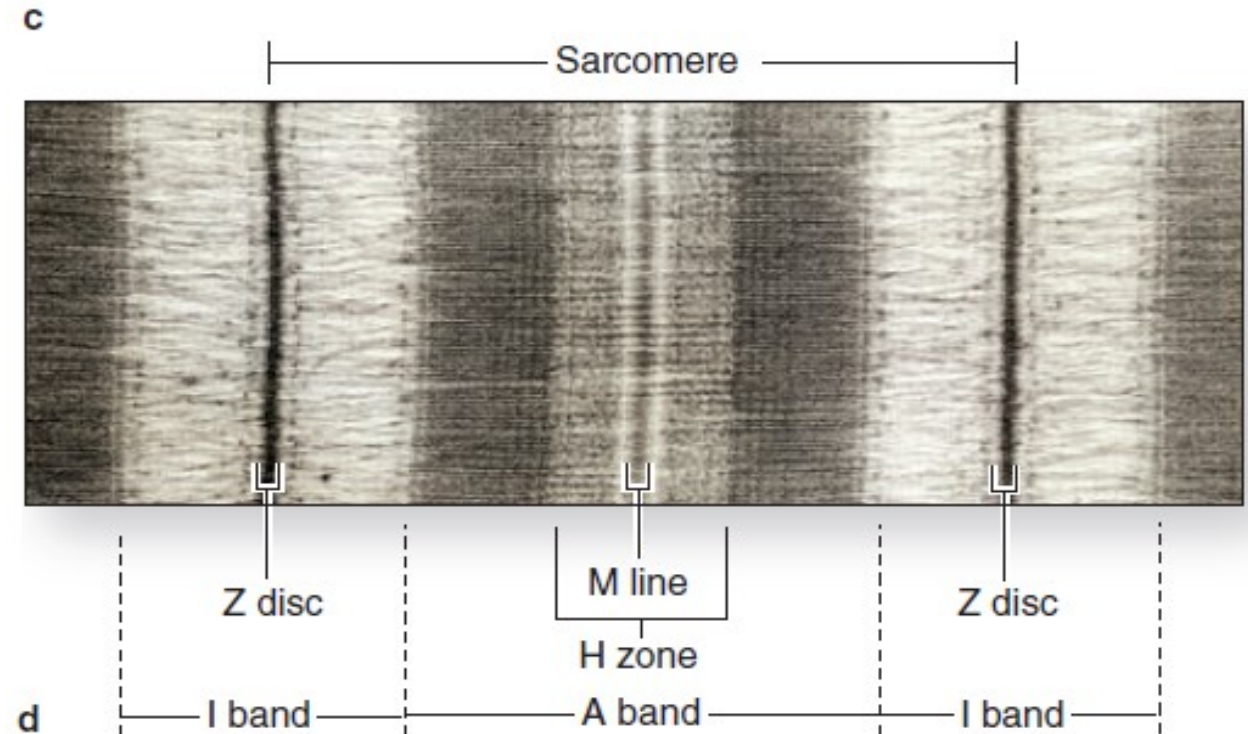
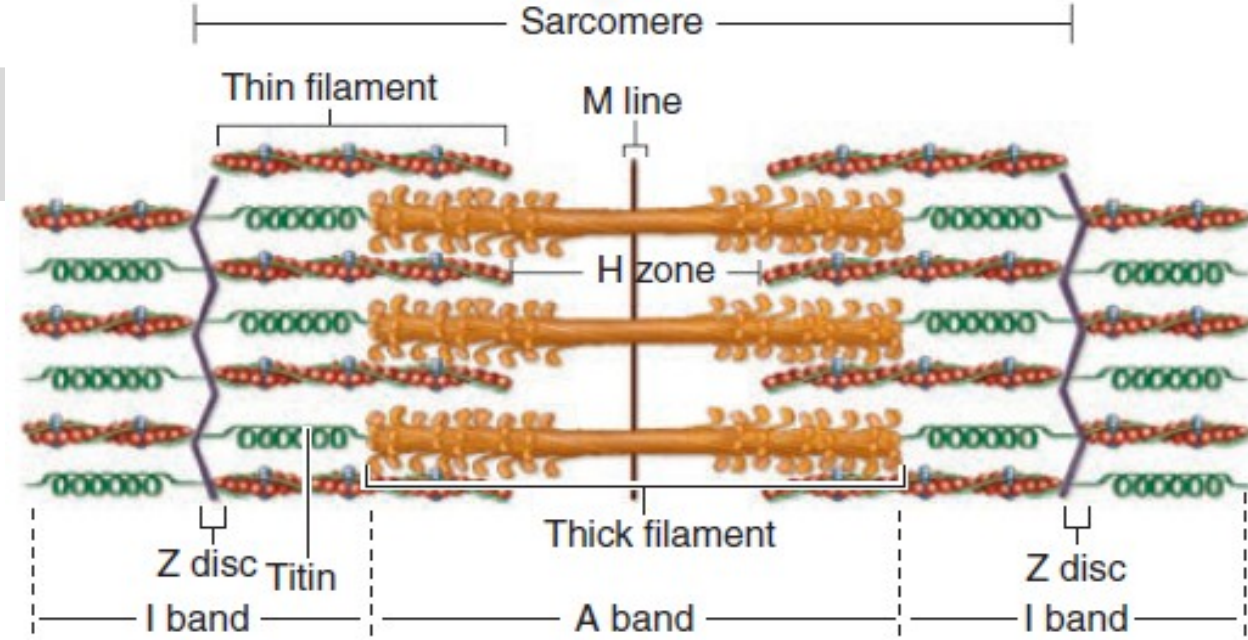
Sarcomere

✓ **I band**: contains actin filaments only. Actin is anchored to Z line (by prot. **Nebulin & α actinin**) but not reaching the middle.

✓ **A-band**: contains both actin & myosin filaments. **Titin** protein binds myosin to Z line.

✓ **H-zone**: (lighter area in the middle of A band) contains **myosin** only.

✓ **M-line**: (is a dark line at the center of H zone) where adjacent myosin are held



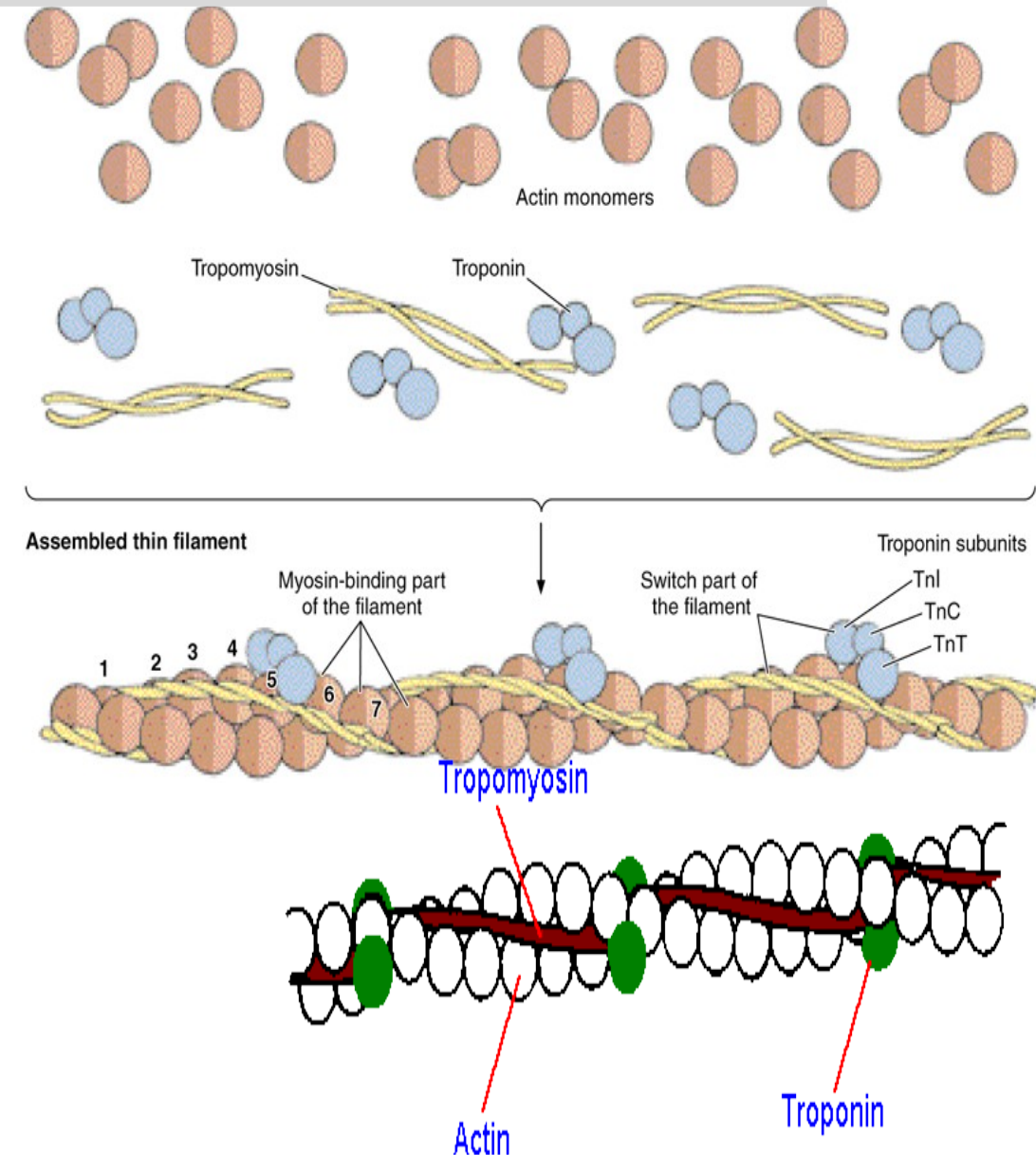
N.B.

- M-line contain myosin-binding protein ***myomesin*** that holds the thick filaments in place, and ***creatine kinase***. This enzyme catalyzes transfer of phosphate groups to ADP → ATP for muscle contraction.

Types of myofilaments (Thin & thick filaments)

1. Thin filament {actin}:

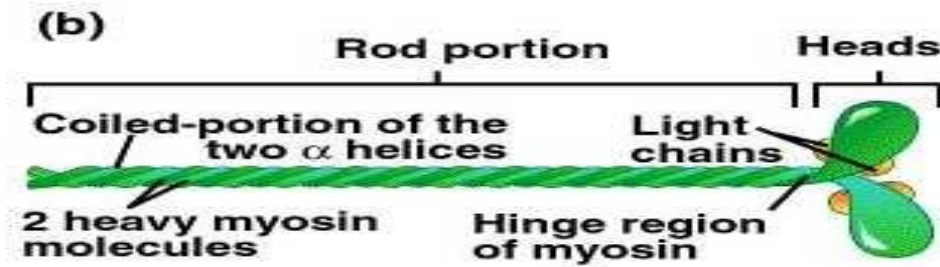
- It is 8nm D.
- It is composed of:
 - **F-actin**: double helical polymer of G-actin protein
 - **Tropomyosin**: coil of two polypeptide chains located in the groove between the two twisted actin strands
 - **Troponin**:
 - ***Tn-I***: inhibit actin myosin interaction.
 - ***Tn-C***: binds to Ca ions.
 - ***Tn-T***: strongly binds to tropomyosin.



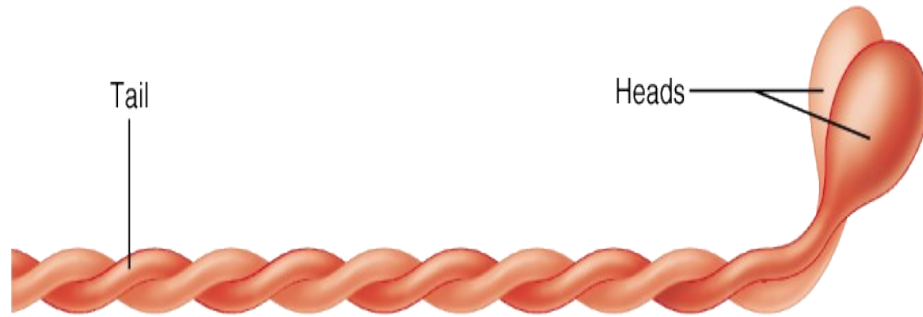
Types of myofilaments (Thin & thick filaments)

2. Thick filament {myosin}:

- It is 15nm Diameter.
- It extends in the **A band only**.
- Attached to the Z line by **titin**
 - It is formed of **two identical heavy chains** and **two pairs of light chains**.
- The myosin heads bind both actin, and ATP.

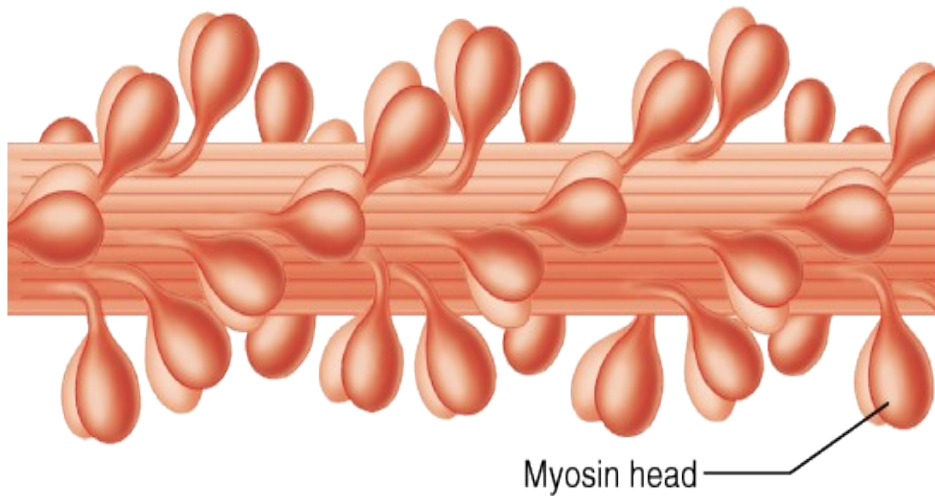


View of myofilaments structure



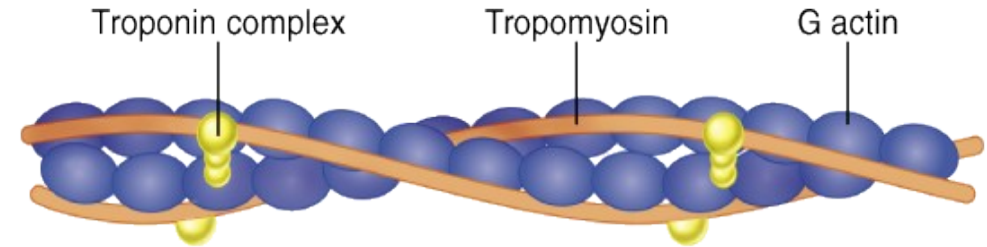
(a) Myosin molecule

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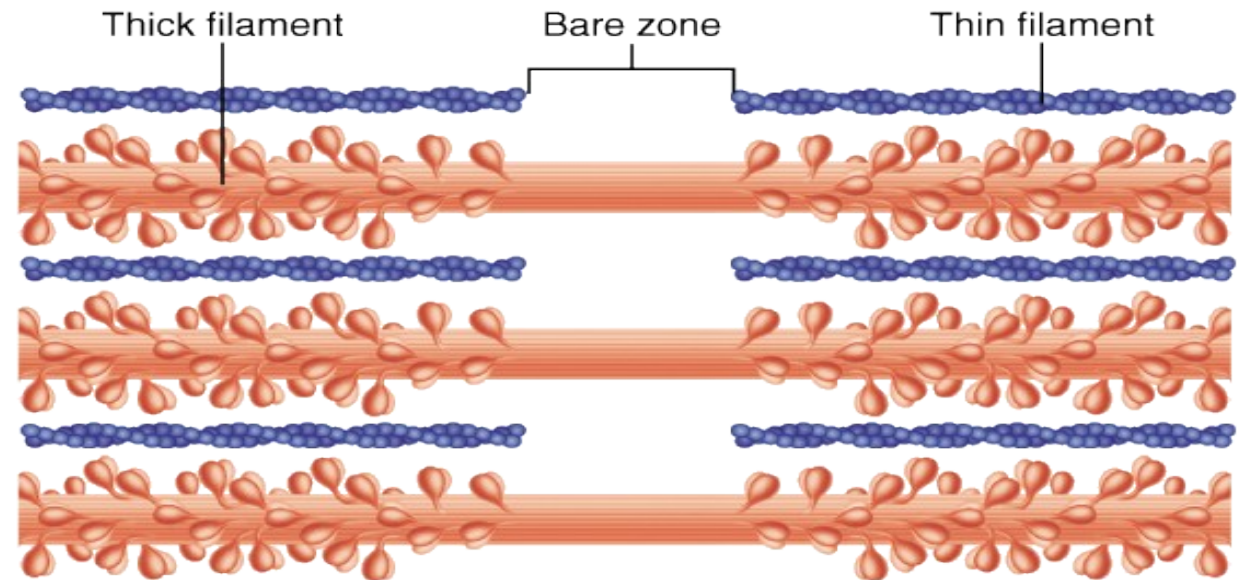
(b) Portion of a thick filament

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(c) Portion of a thin filament

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(d) Longitudinal section of filaments within one sarcomere of a myofibril

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